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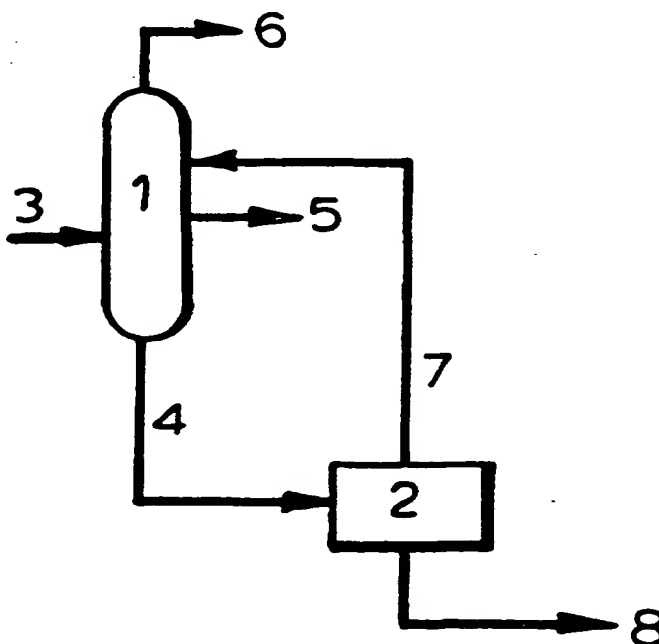
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(54) Title: PROCESS FOR THE CONVERSION OF A HYDROCARBON OIL

(57) Abstract

Process for the thermal conversion of a hydrocarbon oil feed derived from a crude oil via a fractionation comprising at least an atmospheric distillation (1) in a crude distillation unit, which process comprises the steps of: a) subjecting the hydrocarbon oil feed to a thermal conversion treatment (2) and recovering at least one lighter oil fraction (7) and a heavy residual fraction (8), and b) feeding the lighter oil fraction(s) (7) to a crude distillation unit (1), suitably the same crude distillation unit as from which the hydrocarbon oil feed is derived, for further separation.



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PROCESS FOR THE CONVERSION OF A HYDROCARBON OIL

The present invention relates to a process for the conversion of a hydrocarbon oil. More specifically, the present invention relates to a process for converting a hydrocarbon oil by means of thermal conversion.

5 Converting hydrocarbon oils by means of thermal conversion is already known for a long time. Basically, thermal conversion is an endothermic, non-catalytic process in which larger hydrocarbon molecules of hydrocarbon oil fractions are broken into smaller
10 molecules. The energy required for breaking the larger molecules into smaller ones is supplied by heating the hydrocarbon oil feed to a sufficiently high temperature. Well known thermal conversion operations, such as
15 visbreaking and the more severe delayed coking, generally involve a conversion step and a subsequent fractionation step. In the conversion step the actual thermal conversion takes place, whilst in the subsequent
20 separation step the various hydrocarbon oil distillate fractions are recovered from the cracked effluent. When a thermal conversion operation is part of a refinery, it would be advantageous from both an economic and
25 efficiency point of view to integrate the thermal conversion operation as much as possible with other unit operations carried out within the same refinery.

30 In U.S. Patent No. 3,767,564 a process is disclosed, wherein a low pour point fuel is produced from a waxy crude by the steps of subjecting the waxy crude to atmospheric distillation, subjecting the resulting atmospheric residue to visbreaking, separating the visbroken effluent in an atmospheric fractionator into
35 distillate(s) and a residual fraction and subjecting this

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residual fraction to deep vacuum distillation. The vacuum visbroken residue so obtained is then blended with low pour point cutter oil to yield the fuel. The atmospheric distillate(s) obtained from the visbroken effluent may be
5 blended with the waxy crude for fractionation in the first atmospheric distillation step. The fractionation section after the conversion section includes an atmospheric flasher as well as a deep vacuum separation unit in order to obtain a vacuum residue which can be
10 blended with a cutter oil to yield a fuel having the desired quality. It would be economically advantageous if only one single separation step, e.g. a single atmospheric flasher, would be needed after the thermal conversion step, whilst still obtaining a cracked residue
15 which could be suitably applied as a blending component for fuel.

The present invention aims to optimise current thermal conversion operations. More particularly, the present invention aims to provide a process, wherein an
20 optimum integration of on the one hand the required crude oil fractionation capacity in a refinery having thermal conversion capacity and on the other hand the fractionation capacity required for separating the thermally cracked effluent can be attained without
25 affecting the yield and quality of both distillates and cracked residue.

Accordingly, the present invention relates to a process for the thermal conversion of a hydrocarbon oil feed derived from a crude oil via a fractionation
30 comprising at least an atmospheric distillation in a crude distillation unit, which process comprises the steps of:

(a) subjecting the hydrocarbon oil feed to a thermal conversion treatment and recovering at least one lighter
35 oil fraction and a heavy residual fraction; and

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(b) feeding the lighter oil fraction(s) to a crude distillation unit for further separation.

With the process according to the present invention the fractionation capacity present in a refinery for
5 fractionating the crude oil feedstock is very efficiently used, i.e. it is also used for fractionation of the lighter oil fractions obtained from the effluent of thermal conversion unit.

10 Crude oil distillation units are well known in the art and many are commercially available. For the purpose of the present invention, any conventional crude oil distillation unit may in principle be applied. A crude oil distillation unit typically comprises several
15 components. The core of the unit is the main atmospheric distillation column, where the primary fractionation of the crude oil takes place. Steam is usually introduced into the column's bottom part for stripping purposes. Before introduction into the main distillation column, the crude oil is first heated in a furnace. Several side
20 stream strippers are usually connected to the main distillation column for recovering various fractions, such as kerosene (kero stripper) and gasoil (gasoil stripper). A naphtha splitter is usually present for recovering the naphtha fraction, whilst a debutanizer is used for recovery of the C3 and C4 hydrocarbon gases. The
25 reflux arranged at the top of the main distillation column usually comprises a condenser and a reflux drum. The vapour fraction leaving the main distillation column at the top is condensed in the condenser and the
30 resulting liquid is passed into the reflux drum. The lightest gases present in the vapour (predominantly C1 and C2) do not condense and are removed as tail gas. One part of the liquid is then reintroduced from the reflux drum into the distillation column in order to control the
35 temperature in the top of the column and to increase the

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separation efficiency, whilst the other part is subjected to further separation. This further separation can be attained in several ways, for instance by feeding the liquid to a naphtha splitter, thereby recovering a liquid naphtha fraction and a vapour fraction, which, after condensation, is (partly) passed to a debutanizer. Alternatively, said further separation can be attained by first feeding the liquid to a debutanizer, where a vapour fraction (C3 and C4) and a liquid fraction are recovered. The latter is then passed to a naphtha splitter. A third possibility involves recontacting the tail gas from the reflux drum after compression with at least part of the liquid from the same reflux drum, further condensing by cooling it and passing the condensed mixture into a second reflux drum. Tail gas is removed from this reflux drum and the remaining liquid can be subjected to further separation in a similar way as described above. At the top of the naphtha splitter and at the top of the debutanizer refluxes similar to the one applied at the top of the main distillation column are suitably applied. At the bottom of the main distillation column the liquid atmospheric residue is withdrawn. The number and composition of the various fractions recovered largely depends on the conditions applied and on the design of the main distillation column.

In a refinery more than one crude distillation unit may be present. It is within the scope of the present invention, to feed the lighter oil fraction(s) obtained after the thermal conversion treatment to another crude distillation unit than from which the hydrocarbon oil feed is derived. This still is advantageous from a (cost) efficiency point of view as optimum use is made of the fractionation facilities present. However, in a most beneficial embodiment of the present invention, step (b) of the process according to the present invention

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comprises feeding the lighter oil fraction(s) recovered after the thermal conversion to the same crude distillation unit as from which the hydrocarbon oil feed is derived. This provides the maximum benefits in terms of process integration and fractionation equipment cost savings.

The hydrocarbon oil feed to be used as a feed in step (a) of the process according to the present invention may be any heavy distillate fraction or residue fraction obtained from the crude distillation unit, optionally via a deasphalting treatment. Suitable feedstocks then include heavy gas oils (cutpoint above 350 °C), both atmospheric and vacuum, atmospheric residues, vacuum residues and deasphalted oils, usually obtained by deasphalting a vacuum residue. Feedstocks most suitably applied for the purpose of the present invention, however, are atmospheric residues and vacuum residues.

Atmospheric residues are obtained as the bottom fraction of the crude distillation unit and typically contain more than 40% by weight and suitably more than 75% by weight of hydrocarbons having a boiling point above 520 °C. Vacuum residues are obtained via the vacuum distillation of the atmospheric residue recovered from the crude distillation unit. Such vacuum residue typically contains more than 80% by weight and suitably more than 90% by weight of hydrocarbons having a boiling point above 520 °C.

The choice between using an atmospheric residue or a vacuum residue as feedstock for the thermal conversion operation is mainly determined by cost factors and upgrading economics. When using an atmospheric residue as the hydrocarbon oil feed, the upstream costs (crude distillation unit) will be lower than in the event a vacuum residue is used (upstream costs involve an extra vacuum distillation unit). On the other hand, the

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downstream costs involved with an atmospheric residue as the feed (thermal conversion reactor, fractionation equipment) are higher than in case a vacuum residue is used (less volume and hence smaller reactors and smaller fractionation equipment necessary). Accordingly, one should weigh high upstream plus low downstream costs (vacuum residue) on the one hand against low upstream plus high downstream costs on the other hand.

Furthermore, if the refinery in which the process according to the present invention is applied has catalytic cracking or hydrocracking capacity, it may be advantageous to use a vacuum residue as the residual hydrocarbon oil feed for the thermal conversion, as the remainder of the atmospheric residue may very suitably be applied as feedstock for the hydrocracker. Savings in diluent necessary as blending component for producing fuel from heavy residual oils may also be of some influence, if the thermal conversion operation is a visbreaking process. In this case, namely, diluent savings may be attained by visbreaking a vacuum residue. If a vacuum residue is used as blending component for producing fuel, relatively large amounts of diluent, usually gasoil, are necessary for obtaining a fuel having the desired viscosity. If this vacuum residue, however, is subjected to visbreaking, the cracked residue can first be diluted with gasoil produced in the visbreaking operation, so that less diluent from an external source is necessary for meeting the fuel's viscosity specification.

The thermal conversion treatment can in principle be carried out according to any thermal conversion process known in the art to be suitable for converting hydrocarbon oils. The preferred thermal conversion processes for the purpose of the present invention,

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however, are visbreaking and the more severe delayed coking.

In general, the final level of conversion of the heavy hydrocarbon molecules into smaller molecules is determined to a large extent by the severity of a thermal conversion process. Two parameters which play an essential role with respect to the severity of a thermal conversion process are residence time and temperature in the conversion zone. The expression "residence time" as used in this respect for continuous thermal conversion operations like visbreaking and furnace cracking refers to the average residence time or space time, which is defined as the quotient of thermal conversion reactor volume and flow rate of the feed, as is well known in the art. A long residence time in combination with a high temperature will result in a high severity, whereas a short residence time in combination with a lower temperature will result in a low severity. Between these two extremes many variations are possible. Conventional operating windows with respect to temperature and residence time are 350 to 600 °C and 0.5 minutes to 10 hours, respectively. In case of the semi-continuous delayed coking, cycle times in the range of from 10 to 30 hours are suitably applied. Cycle time is defined as the time span between two successive decoking operations. It is within the common skills of the person skilled in the art to choose such combination of residence or cycle time and temperature that the desired level of conversion will be achieved.

In this connection it is noted that the formation of coke in the heater coils as a result of the conversion reactions is one of the major constraints in thermal conversion. Especially at high severity's, i.e. at such combination of residence time and temperature that more than 30% by weight of the hydrocarbons having a boiling

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point above 520 °C present in the feed is converted into components having a lower boiling point (520 °C+ conversion of more than 30% by weight), problems due to coke formation may readily occur. Several methods for suppressing the coke formation are known in the art. Operating the process at lower severity, i.e. at 520 °C+ conversion levels below 30% by weight, is a very viable option. This is for instance the case in visbreaking. Other options include deasphalting of the thermal cracker feed in order to remove the heavy asphaltenes which are to a large extent responsible for the coke formation during thermal conversion, or using bypassable coke drums as in delayed coking.

Visbreaking is a well known process. It is a continuous thermal conversion process wherein the conditions are relatively mild (low severity), so that the 520 °C+ conversion level is kept below 30% by weight. A very suitable visbreaking process is the process disclosed in European Patent Application No. 0,007,656. In this process the hydrocarbon oil feed is first preheated, suitably to a temperature in the range of 400 to 500°C, after which the hot feed is caused to flow upwards through a soaking vessel, suitably a soaking vessel having internals. Preferably, the internals are horizontal perforated plates, installed inside the soaker in a number of from 1 to 20. The residence time in the soaker is in the range of from 5 to 60 minutes, preferably from 10 to 40 minutes. However, other visbreaking processes, such as those using soaking vessels without any internals or those employing only a conversion furnace, may also be applied in the process according to the present invention.

Delayed coking is also a well known semi-continuous thermal conversion process, which involves more severe conditions than visbreaking. A delayed coking process

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generally involves preheating the hydrocarbon oil feed, usually to temperatures between 400 and 550 °C, and introducing the hot feed into at least one coke drum where conversion takes place and the coke formed during conversion gradually fills the coke drum. Preheating suitably takes place by passing the fresh feed through the bottom part of the separation column used for fractionating the cracked effluent and subsequently through a furnace. Cycle time in the coke drums can be in the range of from 10 to 30 hours. Usually two or more coke drums are arranged in a parallel mode, so that when one coke drum is full with coke, this coke drum can be bypassed and another drum can be put on-line. The coke is then removed from the full drum, for instance by hydraulic cleaning, and the coke drum is again ready for operation. The vaporous cracked effluent leaves the coker drum at the top for fractionation. For the purpose of the present invention, this cracked effluent need to be separated into one or two lighter oil fractions and a heavy recycle stream only, which is suitably contacted with fresh feed in the bottom of the separation column. This relatively rough separation allows significant cost savings on the separation facilities to be used in comparison with conventional delayed coking operations.

Beside visbreaking and delayed coking, other thermal conversion processes may also be applied. Examples of suitable severe thermal conversion processes are e.g. disclosed in European Patent Applications Nos. 0,202,099 and 0,372,652. These processes involve severe thermal conversion processes wherein a residual hydrocarbon oil is preheated, the hot feed is passed through a thermal conversion zone (suitably a soaking vessel) and the cracked residue is deasphalted. The cracked effluent containing the lighter fractions can very suitably used in step (b) of the process according to the present

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invention. Another suitable severe thermal conversion process is disclosed in European Patent Application No. 0,673,989. The process disclosed in this patent application involves deep deasphalting of the residual hydrocarbon oil feed followed by a severe thermal conversion of the deasphalted oil.

Recovery in step (a) of at least one lighter oil fraction and a cracked residue can be achieved by known fractionation methods, e.g. by an atmospheric and/or vacuum flash column. For the purpose of the present invention, however, a preferred option is to recover the lighter oil fraction(s) in a single recovery step by using a single flash column, suitably an atmospheric flash column. Suitably, the cracked effluent is separated in one or two lighter oil fractions and the liquid cracked residue. The lighter oil fraction(s) recovered may be entirely routed to the crude distillation unit as such. In case the lightest oil fraction or the only lighter oil fraction is a vaporous fraction, this fraction may also be condensed first for heat recovery, after which the entire or part of the condensed fraction is routed to the crude distillation unit. The entire or part of the condensed and cooled lighter oil fraction may also be used for reflux purposes, i.e. it is reintroduced into the flash column in order to control the temperature at the top of the flash column. A combination of all these options is also very well possible: one part of the lighter oil fraction(s) recovered is directly led to the crude distillation unit, whilst the other part is used as a reflux.

In another preferred embodiment of the present invention, recovery of at least one lighter oil fraction in step (a) takes place by means of a so called combi-tower. Such combi-tower essentially is a fractionation column integrated with a distillate cracking furnace for

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upgrading the heavier distillate fractions obtained from the fractionation. Such heavier distillate fractions are routed to the distillate cracking furnace, where cracking takes place. The furnace effluent then is routed back into the combi-tower column for fractionation. The heavy distillates obtained from the combi-tower may be combined with distillate fractions from other sources, such as waxy distillates obtained from a vacuum flasher, prior to entering the distillate cracking furnace. At least one lighter oil fraction is recovered from the combi-tower as the top or overhead fraction. This fraction is suitably produced in a top circulating reflux section of the combi-tower, where the top temperature is controlled by cooled circulating reflux. The top temperature determines the nature of the top fraction (usually naphtha minus or gasoil minus). If combi-tower is used for recovery of one or more lighter oil fractions after thermal conversion, step (a) suitably involves thermal conversion of a residual hydrocarbon oil in a furnace and subsequent soaker vessel, after which the two phase liquid/vapour effluent from the soaker vessel is quenched (e.g. with steam) and fed into a cyclone vessel where liquid and vapours are separated. The vapours are then routed to the combi-tower, whilst the liquid containing the heavy hydrocarbons is suitably quenched and routed to a vacuum flasher for further separation.

If only one lighter oil fraction is recovered in step (a), this fraction is always a vaporous fraction and may be a gasoil minus fraction or a naphtha minus fraction. The expression "gasoil minus fraction" as used in this connection refers to the fraction of hydrocarbons, of which at least 90% by weight of the hydrocarbons, suitably at least 95% by weight, has a boiling point below 400 °C. The expression "naphtha minus fraction" refers to the hydrocarbon oil fraction of which at least

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90% by weight of the hydrocarbons, suitably at least 95% by weight, has a boiling point below 165 °C. If two lighter oil fractions are recovered, these fractions suitably are a naphtha minus fraction and a hydrocarbon oil fraction of which at least 90% by weight has a boiling point between 165 and 400 °C. The latter fraction is conveniently referred to as the gasoil fraction. Alternatively, a gasoil minus fraction and a heavy gasoil fraction (90% by weight of the hydrocarbons present have a boiling point between 350 and 520 °C) may be recovered as the lighter oil fractions. If a naphtha minus fraction is produced, this fraction can suitably be introduced into the reflux, e.g. in the reflux drum, or recontacting system arranged at the top of the main distillation column of the crude distillation unit, but can also be introduced into the top of the main distillation column itself. A (heavy) gasoil fraction or a gasoil minus fraction is suitably introduced into the crude distillation column itself.

Before being introduced into the crude distillation unit, the lighter oil fraction(s) recovered may first be subjected to hydrodesulphurization. Hydrodesulphurization prior to entry in the crude distillation unit may be particularly useful for gasoil minus or (heavy) gasoil fractions.

Hydrodesulphurization of distillates is well known in the art and for the purpose of the present invention any suitable hydrodesulphurization method may in principle be applied. In general, hydrodesulphurization involves contacting the hydrocarbon oil feed with hydrogen in the presence of a suitable catalyst under the appropriate conditions. Suitable catalysts include those comprising as the catalytically active metals a combination of nickel or cobalt on the one hand and molybdenum or tungsten on the other hand, which metals are supported on

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a carrier comprising silica, alumina, silica-alumina or a zeolite, e.g. zeolite Y. Conventional operating conditions include temperatures between 250 and 450 °C and hydrogen partial pressures of from 10 to 100 bar.

5 In case of visbreaking, the cracked residue recovered is very useful -optionally after an additional vacuum flashing treatment- as a blending component in fuel or as a feedstock for partial oxidation (gasification) resulting in a clean gas which can be applied as clean
10 fuel gas in the refinery, for cogeneration of power and steam, for hydrogen manufacture an/or for hydrocarbon synthesis processes. In case of delayed coking, the coke recovered from the coke drums may suitably be applied as petroleum cokes, i.e. it may inter alia serve as a feed
15 for power stations or gasifiers or cogeneration of power and steam, or as anode grade cokes, depending on the type of feedstock used for the delayed coking operation.

 The process according to the present invention is economically very attractive, as it enables significant
20 savings on the fractionation equipment needed, whilst making optimum use of the crude distillation unit. Furthermore, the yield of useful products is also excellent: a very good yield of distillates on the one hand and a useful heavy product (cracked residue, coke,
25 heavy recycle stream) on the other hand.

 The process according to the present invention is further illustrated by Figures 1 and 2. Figure 1 depicts a simplified flow scheme of one embodiment of the present invention, wherein an atmospheric residue is subjected to
30 thermal conversion, whilst Figure 2 shows the embodiment involving the use of a vacuum residue as the feedstock for the thermal conversion.

 In Figure 1 a crude oil (3) is introduced into crude distillation unit (1), where it is separated in top
35 fraction (6), at least one distillate fraction (5) and

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atmospheric residue (4). Atmospheric residue (4) subsequently serves as the feedstock for thermal conversion unit (2), from which are recovered light oil fraction(s) (7) and cracked residue (8). The light oil fraction(s) (7) are then passed into crude oil distillation unit (1) for further separation.

In Figure 2 an additional vacuum distillation step is shown. The reference numbers correspond to those used in Figure 1. Atmospheric residue (4) is subjected to vacuum distillation in vacuum distillation unit (9), resulting in top fraction (12), at least one distillate fraction (11) and vacuum residue (10). The vacuum residue (10) is subsequently converted in thermal conversion unit (2), after which the lighter oil fraction(s) (7) are passed to crude distillation unit (1) for further separation.

The invention is further illustrated by the following examples.

Example 1

About 3300 tonnes/day (t/d) of long residue obtained from a crude distiller at a cutpoint of 350 °C is pumped into a residue cracking furnace and heated to 465 °C. The furnace effluent then flows to a soaker vessel, operated at 3.3 bar, where further cracking takes place. The two phase soaker effluent is quenched with steam and fed into a cyclone vessel where liquid and vapours are separated. The vapours are subsequently routed to a combi-tower for further fractionation and the liquid is further quenched and routed to a vacuum flasher.

In the combi-tower fractionation takes place to yield bottoms, heavy distillate fractions, a gasoil fraction (1232 t/d) and a naphtha minus fraction (560 t/d). The latter fraction leaves the combi-tower as the overhead fraction and is produced in a top circulating reflux section of the combi-tower, whereby the combi-tower top temperature is controlled at 94 °C by cooled circulating

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reflux to achieve the cutpoint between gasoil and naphtha minus. The gasoil fraction has an initial boiling point of 192 °C, a 10% volume point of 223 °C and 91% by weight boiling below 350 °C. The naphtha minus fraction is
5 routed back to the crude distiller for further fractionation.

The bottom fraction obtained from the vacuum flasher (the vacuum flashed cracked residue) is cooled by integration with the crude oil preheat train, in which
10 the crude oil is preheated prior to entry into the crude distiller.

Example 2

Crude oil is fractionated in a crude distiller and the atmospheric residue obtained as the bottom fraction
15 at a cutpoint of 350 °C is further fractionated in a high vacuum unit. The vacuum residue obtained as the bottom fraction (3200 t/d) is routed to the cracking furnace operating at 450-460 °C outlet temperature. Further cracking is achieved in the subsequent soaker column
20 (inlet pressure 9 bar). The two phase soaker effluent is then quenched to a temperature of 400 °C and separated in a flash column into liquid and vapour. The vapour, combined with the stripping stream and stripping vapours from the bottom part of the flash column, is partially
25 cooled to 320 °C in the top part of the flash column by means of a spray section. Circulating spray liquid and condensed cracked distillate are drawn off and routed to a top circulating reflux vessel. Part of the liquid stream from this vessel is used for top reflux, the net
30 condensed liquid is routed to the crude distiller for further fractionation. Vapours, obtained as the top fraction from the flash column, are cooled and also routed (at a pressure of 2.3 bar) to the crude distiller for further fractionation.

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The heat removed in the spray section of the flash column and the heat removed in the quench operations mentioned above is used to preheat the crude oil prior to entering the crude distiller.

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C L A I M S

1. Process for the thermal conversion of a hydrocarbon oil feed derived from a crude oil via a fractionation comprising at least an atmospheric distillation in a crude distillation unit, which process comprises the steps of:

(a) subjecting the hydrocarbon oil feed to a thermal conversion treatment and recovering at least one lighter oil fraction and a heavy residual fraction; and

(b) feeding the lighter oil fraction(s) to a crude distillation unit for further separation.

2. Process according to claim 1, wherein step (b) comprises feeding the lighter oil fraction(s) to the same crude distillation unit as from which the hydrocarbon oil feed is derived.

3. Process according to claim 1 or 2, wherein the hydrocarbon oil feed is an atmospheric residue directly obtained from the crude distillation unit.

4. Process according to claim 1 or 2, wherein the hydrocarbon oil feed is a vacuum residue obtained via the atmospheric distillation of a crude oil in the crude distillation unit followed by vacuum distillation of the atmospheric residue recovered from the crude distillation unit.

5. Process according to any one of claims 1 to 4, wherein the thermal conversion treatment is a visbreaking treatment.

6. Process according to claim 5, wherein the visbreaking treatment comprises first preheating the feed, suitably to a temperature in the range of 400 to 500°C, subsequently causing the hot feed to flow upwards through a soaking vessel, suitably a soaking vessel having

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internals, the residence time in the soaking vessel being in the range of from 5 to 60 minutes, after which the soaker effluent is separated into at least one lighter oil fraction and a cracked residue.

5 7. Process according to any one of claims 1 to 4, wherein the thermal conversion treatment is a delayed coking treatment.

10 8. Process according to any one of claims 1 to 7, wherein the single lighter oil fraction recovered from the thermal conversion treatment and sent to the crude distillation unit is a gasoil minus fraction or a naphtha minus fraction.

15 9. Process according to any one of claims 1 to 7, wherein the lighter oil fractions recovered from the thermal conversion treatment and sent to the crude distillation unit are a naphtha minus fraction and a gasoil fraction.

20 10. Process according to claim 8 or 9, wherein the gasoil minus fraction or the gasoil fraction is first subjected to hydrodesulphurization prior to being introduced into the crude distillation unit.

25 11. Process according to any one of claims 8 to 10, wherein the naphtha minus fraction is introduced into the reflux or recontacting system arranged at the top of the main distillation column of the crude distillation unit.

INTERNATIONAL SEARCH REPORT

Int. Patent Application No
PCT/EP 96/00850A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C10G9/00 C10G69/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,3 767 564 (TEXACO) 23 October 1973 cited in the application see figure 2	1-3,5,8, 9
Y	---	6
Y	EP,A,0 007 656 (SHELL) 6 February 1980 cited in the application see the whole document -----	6

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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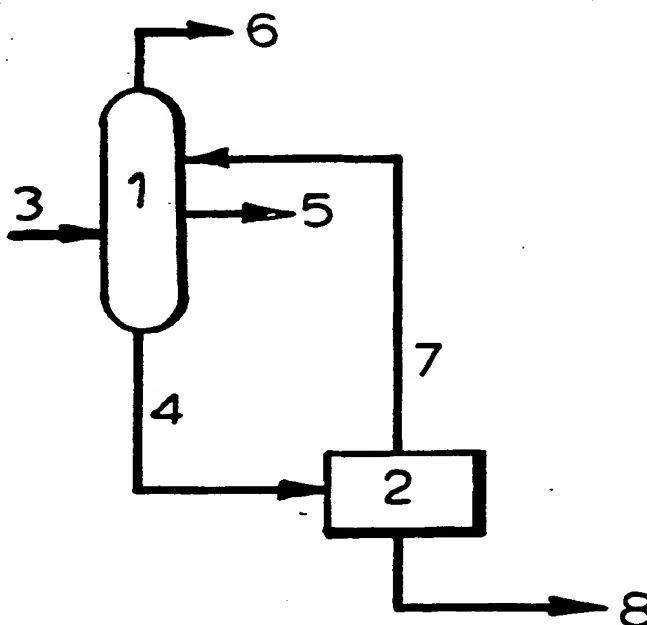
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(54) Title: PROCESS FOR THE CONVERSION OF A HYDROCARBON OIL

(57) Abstract

Process for the thermal conversion of a hydrocarbon oil feed derived from a crude oil via a fractionation comprising at least an atmospheric distillation (1) in a crude distillation unit, which process comprises the steps of: a) subjecting the hydrocarbon oil feed to a thermal conversion treatment (2) and recovering at least one lighter oil fraction (7) and a heavy residual fraction (8), and b) feeding the lighter oil fraction(s) (7) to a crude distillation unit (1), suitably the same crude distillation unit as from which the hydrocarbon oil feed is derived, for further separation.



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PROCESS FOR THE CONVERSION OF A HYDROCARBON OIL

The present invention relates to a process for the conversion of a hydrocarbon oil. More specifically, the present invention relates to a process for converting a hydrocarbon oil by means of thermal conversion.

5 Converting hydrocarbon oils by means of thermal conversion is already known for a long time. Basically, thermal conversion is an endothermic, non-catalytic process in which larger hydrocarbon molecules of hydrocarbon oil fractions are broken into smaller
10 molecules. The energy required for breaking the larger molecules into smaller ones is supplied by heating the hydrocarbon oil feed to a sufficiently high temperature. Well known thermal conversion operations, such as visbreaking and the more severe delayed coking, generally
15 involve a conversion step and a subsequent fractionation step. In the conversion step the actual thermal conversion takes place, whilst in the subsequent separation step the various hydrocarbon oil distillate fractions are recovered from the cracked effluent. When a
20 thermal conversion operation is part of a refinery, it would be advantageous from both an economic and efficiency point of view to integrate the thermal conversion operation as much as possible with other unit operations carried out within the same refinery.

25 In U.S. Patent No. 3,767,564 a process is disclosed, wherein a low pour point fuel is produced from a waxy crude by the steps of subjecting the waxy crude to atmospheric distillation, subjecting the resulting atmospheric residue to visbreaking, separating the
30 visbroken effluent in an atmospheric fractionator into distillate(s) and a residual fraction and subjecting this

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residual fraction to deep vacuum distillation. The vacuum visbroken residue so obtained is then blended with low pour point cutter oil to yield the fuel. The atmospheric distillate(s) obtained from the visbroken effluent may be
5 blended with the waxy crude for fractionation in the first atmospheric distillation step. The fractionation section after the conversion section includes an atmospheric flasher as well as a deep vacuum separation unit in order to obtain a vacuum residue which can be
10 blended with a cutter oil to yield a fuel having the desired quality. It would be economically advantageous if only one single separation step, e.g. a single atmospheric flasher, would be needed after the thermal conversion step, whilst still obtaining a cracked residue
15 which could be suitably applied as a blending component for fuel.

The present invention aims to optimise current thermal conversion operations. More particularly, the present invention aims to provide a process, wherein an
20 optimum integration of on the one hand the required crude oil fractionation capacity in a refinery having thermal conversion capacity and on the other hand the fractionation capacity required for separating the thermally cracked effluent can be attained without
25 affecting the yield and quality of both distillates and cracked residue.

Accordingly, the present invention relates to a process for the thermal conversion of a hydrocarbon oil feed derived from a crude oil via a fractionation
30 comprising at least an atmospheric distillation in a crude distillation unit, which process comprises the steps of:

(a) subjecting the hydrocarbon oil feed to a thermal conversion treatment and recovering at least one lighter
35 oil fraction and a heavy residual fraction; and

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(b) feeding the lighter oil fraction(s) to a crude distillation unit for further separation.

With the process according to the present invention the fractionation capacity present in a refinery for
5 fractionating the crude oil feedstock is very efficiently used, i.e. it is also used for fractionation of the lighter oil fractions obtained from the effluent of thermal conversion unit.

10 Crude oil distillation units are well known in the art and many are commercially available. For the purpose of the present invention, any conventional crude oil distillation unit may in principle be applied. A crude oil distillation unit typically comprises several
15 components. The core of the unit is the main atmospheric distillation column, where the primary fractionation of the crude oil takes place. Steam is usually introduced into the column's bottom part for stripping purposes. Before introduction into the main distillation column,
20 the crude oil is first heated in a furnace. Several side stream strippers are usually connected to the main distillation column for recovering various fractions, such as kerosene (kero stripper) and gasoil (gasoil
stripper). A naphtha splitter is usually present for recovering the naphtha fraction, whilst a debutanizer is
25 used for recovery of the C3 and C4 hydrocarbon gases. The reflux arranged at the top of the main distillation column usually comprises a condenser and a reflux drum. The vapour fraction leaving the main distillation column
30 at the top is condensed in the condenser and the resulting liquid is passed into the reflux drum. The lightest gases present in the vapour (predominantly C1 and C2) do not condense and are removed as tail gas. One part of the liquid is then reintroduced from the reflux
35 drum into the distillation column in order to control the temperature in the top of the column and to increase the

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separation efficiency, whilst the other part is subjected to further separation. This further separation can be attained in several ways, for instance by feeding the liquid to a naphtha splitter, thereby recovering a liquid naphtha fraction and a vapour fraction, which, after condensation, is (partly) passed to a debutanizer. Alternatively, said further separation can be attained by first feeding the liquid to a debutanizer, where a vapour fraction (C3 and C4) and a liquid fraction are recovered. The latter is then passed to a naphtha splitter. A third possibility involves recontacting the tail gas from the reflux drum after compression with at least part of the liquid from the same reflux drum, further condensing by cooling it and passing the condensed mixture into a second reflux drum. Tail gas is removed from this reflux drum and the remaining liquid can be subjected to further separation in a similar way as described above. At the top of the naphtha splitter and at the top of the debutanizer refluxes similar to the one applied at the top of the main distillation column are suitably applied. At the bottom of the main distillation column the liquid atmospheric residue is withdrawn. The number and composition of the various fractions recovered largely depends on the conditions applied and on the design of the main distillation column.

In a refinery more than one crude distillation unit may be present. It is within the scope of the present invention, to feed the lighter oil fraction(s) obtained after the thermal conversion treatment to another crude distillation unit than from which the hydrocarbon oil feed is derived. This still is advantageous from a (cost) efficiency point of view as optimum use is made of the fractionation facilities present. However, in a most beneficial embodiment of the present invention, step (b) of the process according to the present invention

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comprises feeding the lighter oil fraction(s) recovered after the thermal conversion to the same crude distillation unit as from which the hydrocarbon oil feed is derived. This provides the maximum benefits in terms of process integration and fractionation equipment cost savings.

The hydrocarbon oil feed to be used as a feed in step (a) of the process according to the present invention may be any heavy distillate fraction or residue fraction obtained from the crude distillation unit, optionally via a deasphalting treatment. Suitable feedstocks then include heavy gas oils (cutpoint above 350 °C), both atmospheric and vacuum, atmospheric residues, vacuum residues and deasphalted oils, usually obtained by deasphalting a vacuum residue. Feedstocks most suitably applied for the purpose of the present invention, however, are atmospheric residues and vacuum residues.

Atmospheric residues are obtained as the bottom fraction of the crude distillation unit and typically contain more than 40% by weight and suitably more than 75% by weight of hydrocarbons having a boiling point above 520 °C. Vacuum residues are obtained via the vacuum distillation of the atmospheric residue recovered from the crude distillation unit. Such vacuum residue typically contains more than 80% by weight and suitably more than 90% by weight of hydrocarbons having a boiling point above 520 °C.

The choice between using an atmospheric residue or a vacuum residue as feedstock for the thermal conversion operation is mainly determined by cost factors and upgrading economics. When using an atmospheric residue as the hydrocarbon oil feed, the upstream costs (crude distillation unit) will be lower than in the event a vacuum residue is used (upstream costs involve an extra vacuum distillation unit). On the other hand, the

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downstream costs involved with an atmospheric residue as the feed (thermal conversion reactor, fractionation equipment) are higher than in case a vacuum residue is used (less volume and hence smaller reactors and smaller fractionation equipment necessary). Accordingly, one should weigh high upstream plus low downstream costs (vacuum residue) on the one hand against low upstream plus high downstream costs on the other hand.

Furthermore, if the refinery in which the process according to the present invention is applied has catalytic cracking or hydrocracking capacity, it may be advantageous to use a vacuum residue as the residual hydrocarbon oil feed for the thermal conversion, as the remainder of the atmospheric residue may very suitably be applied as feedstock for the hydrocracker. Savings in diluent necessary as blending component for producing fuel from heavy residual oils may also be of some influence, if the thermal conversion operation is a visbreaking process. In this case, namely, diluent savings may be attained by visbreaking a vacuum residue. If a vacuum residue is used as blending component for producing fuel, relatively large amounts of diluent, usually gasoil, are necessary for obtaining a fuel having the desired viscosity. If this vacuum residue, however, is subjected to visbreaking, the cracked residue can first be diluted with gasoil produced in the visbreaking operation, so that less diluent from an external source is necessary for meeting the fuel's viscosity specification.

The thermal conversion treatment can in principle be carried out according to any thermal conversion process known in the art to be suitable for converting hydrocarbon oils. The preferred thermal conversion processes for the purpose of the present invention,

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however, are visbreaking and the more severe delayed coking.

In general, the final level of conversion of the heavy hydrocarbon molecules into smaller molecules is determined to a large extent by the severity of a thermal conversion process. Two parameters which play an essential role with respect to the severity of a thermal conversion process are residence time and temperature in the conversion zone. The expression "residence time" as used in this respect for continuous thermal conversion operations like visbreaking and furnace cracking refers to the average residence time or space time, which is defined as the quotient of thermal conversion reactor volume and flow rate of the feed, as is well known in the art. A long residence time in combination with a high temperature will result in a high severity, whereas a short residence time in combination with a lower temperature will result in a low severity. Between these two extremes many variations are possible. Conventional operating windows with respect to temperature and residence time are 350 to 600 °C and 0.5 minutes to 10 hours, respectively. In case of the semi-continuous delayed coking, cycle times in the range of from 10 to 30 hours are suitably applied. Cycle time is defined as the time span between two successive decoking operations. It is within the common skills of the person skilled in the art to choose such combination of residence or cycle time and temperature that the desired level of conversion will be achieved.

In this connection it is noted that the formation of coke in the heater coils as a result of the conversion reactions is one of the major constraints in thermal conversion. Especially at high severity's, i.e. at such combination of residence time and temperature that more than 30% by weight of the hydrocarbons having a boiling

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point above 520 °C present in the feed is converted into components having a lower boiling point (520 °C+ conversion of more than 30% by weight), problems due to coke formation may readily occur. Several methods for suppressing the coke formation are known in the art. Operating the process at lower severity, i.e. at 520 °C+ conversion levels below 30% by weight, is a very viable option. This is for instance the case in visbreaking. Other options include deasphalting of the thermal cracker feed in order to remove the heavy asphaltenes which are to a large extent responsible for the coke formation during thermal conversion, or using bypassable coke drums as in delayed coking.

Visbreaking is a well known process. It is a continuous thermal conversion process wherein the conditions are relatively mild (low severity), so that the 520 °C+ conversion level is kept below 30% by weight. A very suitable visbreaking process is the process disclosed in European Patent Application No. 0,007,656. In this process the hydrocarbon oil feed is first preheated, suitably to a temperature in the range of 400 to 500°C, after which the hot feed is caused to flow upwards through a soaking vessel, suitably a soaking vessel having internals. Preferably, the internals are horizontal perforated plates, installed inside the soaker in a number of from 1 to 20. The residence time in the soaker is in the range of from 5 to 60 minutes, preferably from 10 to 40 minutes. However, other visbreaking processes, such as those using soaking vessels without any internals or those employing only a conversion furnace, may also be applied in the process according to the present invention.

Delayed coking is also a well known semi-continuous thermal conversion process, which involves more severe conditions than visbreaking. A delayed coking process

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generally involves preheating the hydrocarbon oil feed, usually to temperatures between 400 and 550 °C, and introducing the hot feed into at least one coke drum where conversion takes place and the coke formed during conversion gradually fills the coke drum. Preheating suitably takes place by passing the fresh feed through the bottom part of the separation column used for fractionating the cracked effluent and subsequently through a furnace. Cycle time in the coke drums can be in the range of from 10 to 30 hours. Usually two or more coke drums are arranged in a parallel mode, so that when one coke drum is full with coke, this coke drum can be bypassed and another drum can be put on-line. The coke is then removed from the full drum, for instance by hydraulic cleaning, and the coke drum is again ready for operation. The vaporous cracked effluent leaves the coker drum at the top for fractionation. For the purpose of the present invention, this cracked effluent need to be separated into one or two lighter oil fractions and a heavy recycle stream only, which is suitably contacted with fresh feed in the bottom of the separation column. This relatively rough separation allows significant cost savings on the separation facilities to be used in comparison with conventional delayed coking operations.

Beside visbreaking and delayed coking, other thermal conversion processes may also be applied. Examples of suitable severe thermal conversion processes are e.g. disclosed in European Patent Applications Nos. 0,202,099 and 0,372,652. These processes involve severe thermal conversion processes wherein a residual hydrocarbon oil is preheated, the hot feed is passed through a thermal conversion zone (suitably a soaking vessel) and the cracked residue is deasphalted. The cracked effluent containing the lighter fractions can very suitably used in step (b) of the process according to the present

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invention. Another suitable severe thermal conversion process is disclosed in European Patent Application No. 0,673,989. The process disclosed in this patent application involves deep deasphalting of the residual hydrocarbon oil feed followed by a severe thermal conversion of the deasphalted oil.

Recovery in step (a) of at least one lighter oil fraction and a cracked residue can be achieved by known fractionation methods, e.g. by an atmospheric and/or vacuum flash column. For the purpose of the present invention, however, a preferred option is to recover the lighter oil fraction(s) in a single recovery step by using a single flash column, suitably an atmospheric flash column. Suitably, the cracked effluent is separated in one or two lighter oil fractions and the liquid cracked residue. The lighter oil fraction(s) recovered may be entirely routed to the crude distillation unit as such. In case the lightest oil fraction or the only lighter oil fraction is a vaporous fraction, this fraction may also be condensed first for heat recovery, after which the entire or part of the condensed fraction is routed to the crude distillation unit. The entire or part of the condensed and cooled lighter oil fraction may also be used for reflux purposes, i.e. it is reintroduced into the flash column in order to control the temperature at the top of the flash column. A combination of all these options is also very well possible: one part of the lighter oil fraction(s) recovered is directly led to the crude distillation unit, whilst the other part is used as a reflux.

In another preferred embodiment of the present invention, recovery of at least one lighter oil fraction in step (a) takes place by means of a so called combi-tower. Such combi-tower essentially is a fractionation column integrated with a distillate cracking furnace for

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upgrading the heavier distillate fractions obtained from the fractionation. Such heavier distillate fractions are routed to the distillate cracking furnace, where cracking takes place. The furnace effluent then is routed back into the combi-tower column for fractionation. The heavy distillates obtained from the combi-tower may be combined with distillate fractions from other sources, such as waxy distillates obtained from a vacuum flasher, prior to entering the distillate cracking furnace. At least one lighter oil fraction is recovered from the combi-tower as the top or overhead fraction. This fraction is suitably produced in a top circulating reflux section of the combi-tower, where the top temperature is controlled by cooled circulating reflux. The top temperature determines the nature of the top fraction (usually naphtha minus or gasoil minus). If combi-tower is used for recovery of one or more lighter oil fractions after thermal conversion, step (a) suitably involves thermal conversion of a residual hydrocarbon oil in a furnace and subsequent soaker vessel, after which the two phase liquid/vapour effluent from the soaker vessel is quenched (e.g. with steam) and fed into a cyclone vessel where liquid and vapours are separated. The vapours are then routed to the combi-tower, whilst the liquid containing the heavy hydrocarbons is suitably quenched and routed to a vacuum flasher for further separation.

If only one lighter oil fraction is recovered in step (a), this fraction is always a vaporous fraction and may be a gasoil minus fraction or a naphtha minus fraction. The expression "gasoil minus fraction" as used in this connection refers to the fraction of hydrocarbons, of which at least 90% by weight of the hydrocarbons, suitably at least 95% by weight, has a boiling point below 400 °C. The expression "naphtha minus fraction" refers to the hydrocarbon oil fraction of which at least

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90% by weight of the hydrocarbons, suitably at least 95% by weight, has a boiling point below 165 °C. If two lighter oil fractions are recovered, these fractions suitably are a naphtha minus fraction and a hydrocarbon oil fraction of which at least 90% by weight has a boiling point between 165 and 400 °C. The latter fraction is conveniently referred to as the gasoil fraction. Alternatively, a gasoil minus fraction and a heavy gasoil fraction (90% by weight of the hydrocarbons present have a boiling point between 350 and 520 °C) may be recovered as the lighter oil fractions. If a naphtha minus fraction is produced, this fraction can suitably be introduced into the reflux, e.g. in the reflux drum, or recontacting system arranged at the top of the main distillation column of the crude distillation unit, but can also be introduced into the top of the main distillation column itself. A (heavy) gasoil fraction or a gasoil minus fraction is suitably introduced into the crude distillation column itself.

Before being introduced into the crude distillation unit, the lighter oil fraction(s) recovered may first be subjected to hydrodesulphurization. Hydrodesulphurization prior to entry in the crude distillation unit may be particularly useful for gasoil minus or (heavy) gasoil fractions.

Hydrodesulphurization of distillates is well known in the art and for the purpose of the present invention any suitable hydrodesulphurization method may in principle be applied. In general, hydrodesulphurization involves contacting the hydrocarbon oil feed with hydrogen in the presence of a suitable catalyst under the appropriate conditions. Suitable catalysts include those comprising as the catalytically active metals a combination of nickel or cobalt on the one hand and molybdenum or tungsten on the other hand, which metals are supported on

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a carrier comprising silica, alumina, silica-alumina or a zeolite, e.g. zeolite Y. Conventional operating conditions include temperatures between 250 and 450 °C and hydrogen partial pressures of from 10 to 100 bar.

5 In case of visbreaking, the cracked residue recovered is very useful -optionally after an additional vacuum flashing treatment- as a blending component in fuel or as a feedstock for partial oxidation (gasification) resulting in a clean gas which can be applied as clean
10 fuel gas in the refinery, for cogeneration of power and steam, for hydrogen manufacture an/or for hydrocarbon synthesis processes. In case of delayed coking, the coke recovered from the coke drums may suitably be applied as petroleum cokes, i.e. it may inter alia serve as a feed
15 for power stations or gasifiers or cogeneration of power and steam, or as anode grade cokes, depending on the type of feedstock used for the delayed coking operation.

 The process according to the present invention is economically very attractive, as it enables significant
20 savings on the fractionation equipment needed, whilst making optimum use of the crude distillation unit. Furthermore, the yield of useful products is also excellent: a very good yield of distillates on the one
25 hand and a useful heavy product (cracked residue, coke, heavy recycle stream) on the other hand.

 The process according to the present invention is further illustrated by Figures 1 and 2. Figure 1 depicts a simplified flow scheme of one embodiment of the present invention, wherein an atmospheric residue is subjected to
30 thermal conversion, whilst Figure 2 shows the embodiment involving the use of a vacuum residue as the feedstock for the thermal conversion.

 In Figure 1 a crude oil (3) is introduced into crude distillation unit (1), where it is separated in top
35 fraction (6), at least one distillate fraction (5) and

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atmospheric residue (4). Atmospheric residue (4) subsequently serves as the feedstock for thermal conversion unit (2), from which are recovered light oil fraction(s) (7) and cracked residue (8). The light oil fraction(s) (7) are then passed into crude oil distillation unit (1) for further separation.

In Figure 2 an additional vacuum distillation step is shown. The reference numbers correspond to those used in Figure 1. Atmospheric residue (4) is subjected to vacuum distillation in vacuum distillation unit (9), resulting in top fraction (12), at least one distillate fraction (11) and vacuum residue (10). The vacuum residue (10) is subsequently converted in thermal conversion unit (2), after which the lighter oil fraction(s) (7) are passed to crude distillation unit (1) for further separation.

The invention is further illustrated by the following examples.

Example 1

About 3300 tonnes/day (t/d) of long residue obtained from a crude distiller at a cutpoint of 350 °C is pumped into a residue cracking furnace and heated to 465 °C. The furnace effluent then flows to a soaker vessel, operated at 3.3 bar, where further cracking takes place. The two phase soaker effluent is quenched with steam and fed into a cyclone vessel where liquid and vapours are separated. The vapours are subsequently routed to a combi-tower for further fractionation and the liquid is further quenched and routed to a vacuum flasher.

In the combi-tower fractionation takes place to yield bottoms, heavy distillate fractions, a gasoil fraction (1232 t/d) and a naphtha minus fraction (560 t/d). The latter fraction leaves the combi-tower as the overhead fraction and is produced in a top circulating reflux section of the combi-tower, whereby the combi-tower top temperature is controlled at 94 °C by cooled circulating

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reflux to achieve the cutpoint between gasoil and naphtha minus. The gasoil fraction has an initial boiling point of 192 °C, a 10% volume point of 223 °C and 91% by weight boiling below 350 °C. The naphtha minus fraction is
5 routed back to the crude distiller for further fractionation.

The bottom fraction obtained from the vacuum flasher (the vacuum flashed cracked residue) is cooled by integration with the crude oil preheat train, in which
10 the crude oil is preheated prior to entry into the crude distiller.

Example 2

Crude oil is fractionated in a crude distiller and the atmospheric residue obtained as the bottom fraction
15 at a cutpoint of 350 °C is further fractionated in a high vacuum unit. The vacuum residue obtained as the bottom fraction (3200 t/d) is routed to the cracking furnace operating at 450-460 °C outlet temperature. Further cracking is achieved in the subsequent soaker column
20 (inlet pressure 9 bar). The two phase soaker effluent is then quenched to a temperature of 400 °C and separated in a flash column into liquid and vapour. The vapour, combined with the stripping stream and stripping vapours from the bottom part of the flash column, is partially
25 cooled to 320 °C in the top part of the flash column by means of a spray section. Circulating spray liquid and condensed cracked distillate are drawn off and routed to a top circulating reflux vessel. Part of the liquid stream from this vessel is used for top reflux, the net
30 condensed liquid is routed to the crude distiller for further fractionation. Vapours, obtained as the top fraction from the flash column, are cooled and also routed (at a pressure of 2.3 bar) to the crude distiller for further fractionation.

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The heat removed in the spray section of the flash column and the heat removed in the quench operations mentioned above is used to preheat the crude oil prior to entering the crude distiller.

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C L A I M S

1. Process for the thermal conversion of a hydrocarbon oil feed derived from a crude oil via a fractionation comprising at least an atmospheric distillation in a crude distillation unit, which process comprises the steps of:
- 5 (a) subjecting the hydrocarbon oil feed to a thermal conversion treatment and recovering at least one lighter oil fraction and a heavy residual fraction; and
- 10 (b) feeding the lighter oil fraction(s) to a crude distillation unit for further separation.
2. Process according to claim 1, wherein step (b) comprises feeding the lighter oil fraction(s) to the same crude distillation unit as from which the hydrocarbon oil feed is derived.
- 15 3. Process according to claim 1 or 2, wherein the hydrocarbon oil feed is an atmospheric residue directly obtained from the crude distillation unit.
4. Process according to claim 1 or 2, wherein the hydrocarbon oil feed is a vacuum residue obtained via the atmospheric distillation of a crude oil in the crude
- 20 distillation unit followed by vacuum distillation of the atmospheric residue recovered from the crude distillation unit.
5. Process according to any one of claims 1 to 4, wherein the thermal conversion treatment is a visbreaking treatment.
- 25 6. Process according to claim 5, wherein the visbreaking treatment comprises first preheating the feed, suitably to a temperature in the range of 400 to 500°C,
- 30 subsequently causing the hot feed to flow upwards through a soaking vessel, suitably a soaking vessel having

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internals, the residence time in the soaking vessel being in the range of from 5 to 60 minutes, after which the soaker effluent is separated into at least one lighter oil fraction and a cracked residue.

5 7. Process according to any one of claims 1 to 4, wherein the thermal conversion treatment is a delayed coking treatment.

8. Process according to any one of claims 1 to 7, wherein the single lighter oil fraction recovered from
10 the thermal conversion treatment and sent to the crude distillation unit is a gasoil minus fraction or a naphtha minus fraction.

9. Process according to any one of claims 1 to 7, wherein the lighter oil fractions recovered from the
15 thermal conversion treatment and sent to the crude distillation unit are a naphtha minus fraction and a gasoil fraction.

10. Process according to claim 8 or 9, wherein the gasoil minus fraction or the gasoil fraction is first subjected
20 to hydrodesulphurization prior to being introduced into the crude distillation unit.

11. Process according to any one of claims 8 to 10, wherein the naphtha minus fraction is introduced into the reflux or recontacting system arranged at the top of the
25 main distillation column of the crude distillation unit.

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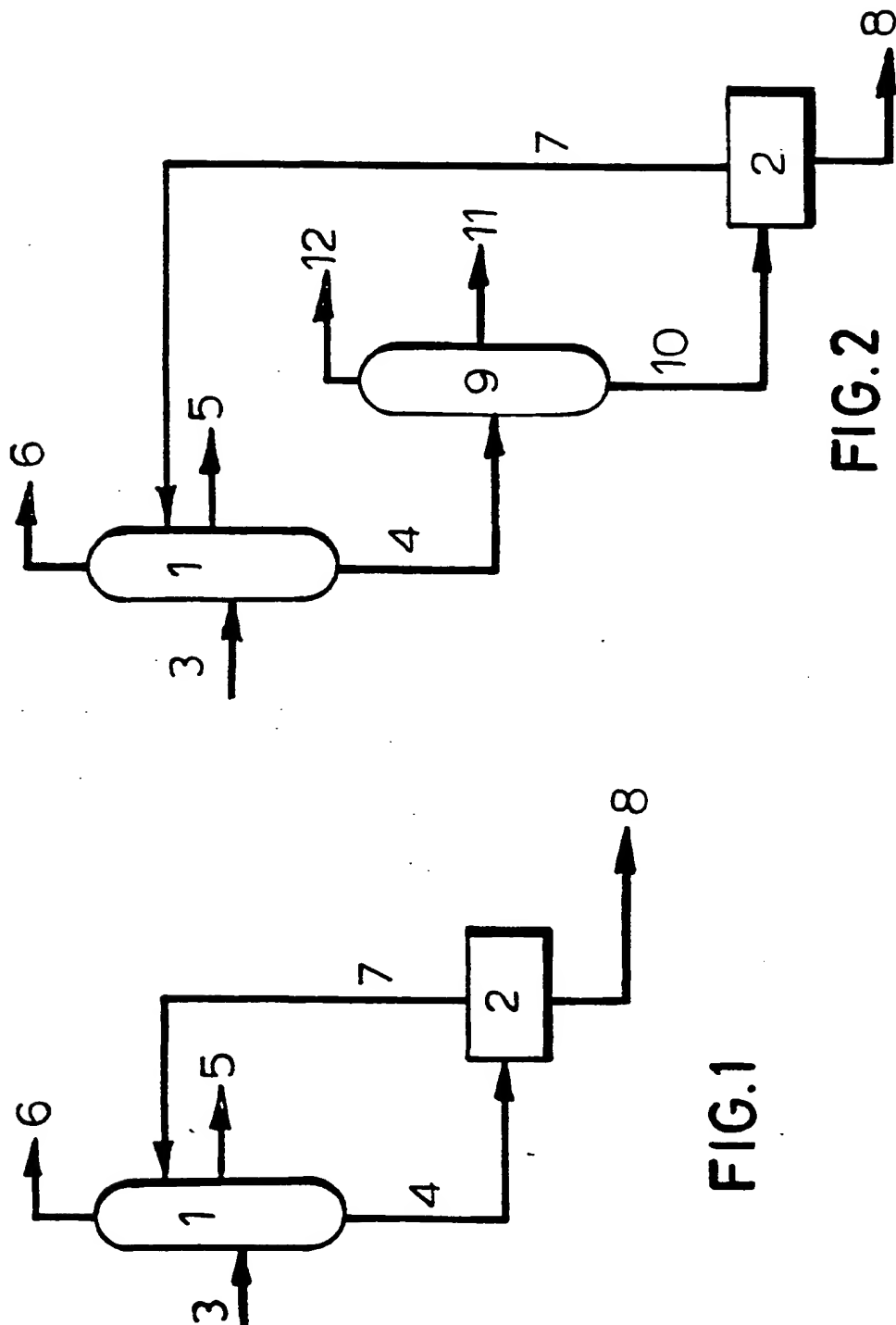


FIG.1

FIG.2

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 96/00850

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C10G9/00 C10G69/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,3 767 564 (TEXACO) 23 October 1973 cited in the application see figure 2	1-3,5,8, 9
Y	---	6
Y	EP,A,0 007 656 (SHELL) 6 February 1980 cited in the application see the whole document -----	6

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

Special categories of cited documents:

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- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *&* document member of the same patent family

Date of the actual completion of the international search

13 June 1996

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 96/00850

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3767564	23-10-73	NONE	

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		CA-A- 1137434	14-12-82
		JP-C- 1469758	14-12-88
		JP-A- 55012198	28-01-80
		JP-B- 63017116	12-04-88
		US-A- 4247387	27-01-81
